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INTERNATIONAL GEOPHYSICAL COOPERATION PROGRAM--SOVIET-BLOC ACTIVITIES

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I. GENERAL

Pulkovo Observatory Marks 120th Year of Founding

The founding of the Pulkovo Observatory, referred to as the oldest scientific institution in the Soviet Union, was observed in the 19 August issue of Pravda. One hundred twenty years have passed since it was established through the initiative of Academician V. Ya. Struve, the famous Russian scientist. The associates of what Pravda calls the "astronomical capital of the world" have made great contributions to science.

The united forces of five continents are engaged in compiling a catalogue of weak stars. This was begun on the suggestion of Pulkovo astronomers. More than 40,000 observations have been conducted at the observatory for this purpose.

Photographs of the Moon and stars are being made there using the television telescope designed by N. F. Kuprevich, an associate of the observatory. Systematic studies of the solar corona are also conducted.

The movements of artificial earth satellites are carefully observed by Pulkovo astronomers.

According to the article, the observatory is now equipped with the latest automatic electronic instruments. The design of the most powerful reflector in the world, the mirror diameter of which is 6 meters, is being developed under the supervision of D. D. Maksutov, Corresponding Member of the Academy of Sciences USSR. With the aid of this instrument various astronomical observations will be carried out. ("Pulkovo Observatory -- 120 Years"; Moscow, Pravda, 19 Aug 59, p 6)

II. UPPER ATMOSPHERE

Diffusion of the F2-Layer and Solar Activity Over Ashkhabad

An analysis of materials from observations of Soviet ionosphere stations (Bukhta Tiksi, Leningrad, Sverdlovsk, Tomsk, Moscow, Irkutsk, Rostov on the Don, and Alma Ata) for several years, and in particular the observations of the Ashkhabad ionosphere station for 9 years, by N. M. Yerofeyev, Institute of Physics and Geophysics, Academy of Sciences Turkmen SSR, gives the following information.

The diffused state of the atmosphere is characterized by special types of reflections which are referred to as diffused reflections, multiple reflections and scattered reflections. These are noted, for simplicity, in tables of ionospheric data by the symbol F. They are grouped under the term F-reflections in the article.

F-reflections sometimes embrace almost all frequency ranges, but in the majority of cases are noted only close to the critical frequency. Using the material of observations of other stations than Ashkhabad in the form of tables only, the F-reflections are divided into three types: Full diffusion (symbol F), strong diffusion (doubtful critical frequencies because of diffusion), and weak diffusion (the presence of a symbol near the numerical value of the critical frequency).

On the basis of experimental material from the Ashkhabad ionosphere station (S 126, 37 55 N, 58 18 E) and the published data of observations from other ionosphere stations in the Soviet Union, work was conducted on determining the diurnal variation, on the change according to the season of the year and the duration of the solar cycle, and also, partially, on the latitudinal distribution of F-reflections.

The regularity of the appearance of F-reflections from the F_2 layer of the ionosphere in the course of a day appears to be almost identical for all stations throughout the world. The maximum number of cases of F-reflections occur in the night hours of local time after midnight. The diurnal variation for cases of F-reflections for all the stations of the Soviet Union considered is identical in regularity. A comparison of the average annual daily variations for the appearance of F-reflections at all stations shows that the value of the maximum falls with a decrease in latitude. At the same time, the number of cases of F-reflection recordings in daylight hours decreases more quickly, and in the latitude of Ashkhabad they are almost completely absent. For the middle latitudes, the daylight hours are a forbidden time for the appearance of a diffused state of the F2 layer if this diffusion did not arise at night.

A decrease in the number of cases of F-reflections for night and daytime in the summer months is characteristic for high latitudes. For middle latitudes, F-reflections in the summer months are noted not only in the daylight hours but also, very rarely, at night. Their maximum number is observed during the winter months. In the latitude of Ashkhabad, F-reflections in the summer months in the night hours appeared as frequently as in winter. Their minimum appearance was noted during the equinoctal months.

Comparing the diurnal changes for cases of F-reflections for stations in different latitudes with illumination of the F-region altitudes by the Sun, the conclusion is made that for each station in the course of a day and season the basic condition, whereby, with initial illumination of the altitudes of the F-region by the Sun the appearance of F-reflections either sharply decreases or completely disappears, is fulfilled.

In the latitude of Ashkhabad during the summer months the altitudes of the F 2 layer are no longer illuminated by the Sun at night and F-reflections occur, whereby, in addition to the winter maximum, a summer maximum also appears.

It is considered of importance to examine the seasonal changes for cases of F-reflections separately for Washington, D. C.- Aashkhabad and Moscow Irkutsk, which have approximately the same geographical latitudes but differ as to geomagnetic latitudes. This is especially true for the first two stations. In regard to diurnal variation, the nature of its change remains the same for all the stations, but in regard to seasonal changes a considerable difference is noted particularly for Washington and Ashkhabad. Moscow and Irkutsk have an insignificant difference. Washington, in contrast to Ashkhabad, has a seasonal variation and the percentage of the appearance of F-reflections is approximately the same as given by Soviet high latitude stations.

Thus, it is assumed that the conditions for the appearance of F-reflections depend on the geomagnetic coördinates. In this regard, a recent work of Reber (Reber and Grote, Spread F Over Washington, <u>I. Geophys. Res.</u>, No 2, 1956, p 61) is mentioned, in which the existence of two types of scattering layers are noted, an F-Equatorial and an F-Arctic. The Equatorial layer is arranged in the form of a great circle, approximately parallel to the geomagnetic Equator, the density of which oscillates approximately within the limits of ± 25 percent. It was found that during the time of minimum solar activity the Equatorial-type layer frequently appeared and spread into the higher latitudes, and in the period of maximum solar activity the Arctic-type layer frequently arises.

The change in the number of F-reflection appearances depending on solar activity for Ashkhabad has an opposite course on the basis of which it is related to the equatorial type.

Several viewpoints are mentioned in regard to the nature of F-reflections. One of the possible explanations for the appearance of diffused reflections is the change in the altitude of the maximum electron concentration of the F-region (H. W. Wells, F scatter at Huancaya, Peru, and Relation to Radio Star Scintillations, I. Geophys. Res., No 2, 1954 p 59).

In 1953, T. Eckersley (T. L. Eckersley, Recombination and Diffusion and Spread, Echoes from the Ionosphere, Proc. Phys. Soc., No 12, 1953, P. 66) suggests that the reason for F-reflections is the periodic change in the density of charged particles with altitude. He showed that such a relationship follows from the solution of a differential equation considering the process of the formation and of the disappearance of charges in the layer on the assumption that corpuscular ionization is the deciding factor. In this work a great deal of attention was devoted to a consideration of the problem of the diffusion of charged particles which play a more significant role in comparison to recombination.

From this viewpoint, two cases of the observation of auroras in Ashkhabad on 4 and 20 September 1957 (Ye. K. Dubrovskaya, State of the Atmosphere, of the Geomagnetic Field and Earth Currents During the Auroras Recorded in Ashkhabad, 4 and 29 September 1957, Izvestiya AN TSSR, No 4, 1958) are considered of great interest. During the 29 September 1957 aurora, a very strong diffusion of the F 2 layer and of F-reflection was observed in the lowest frequencies in the beginning of the high frequency characteristics. In the morning hours, the diffusion disappeared. On 4 September 1957, during the aurora, diffusion of the F2 layer was not observed even in a weak form. Consequently, it is said, corpuscular streams cannot cause a diffused state of the F-region of the ionosphere in all cases. Such a diffused state can appear only during a specific ionospheric condition. Approximately the same idea was set forth in regard to the appearance of ionospheric disturbances by Mednikova (N. V. Mednikova, Ionospheric Disturbances in the Middle Latitudes, Trudy konferentsii Komissii po issledovaniyu Solnitsa, Fizika solnechnykh korpuskulyarnyk potokov i ikh vozdeystviye na verkhnyuyu atmosferu Zemli, AN SSSR, 1957).

On the strength of these reasons, the work of V. L. Ginzburg (V. L. Ginzburg, On the Mechanism of the Formation of Ionospheric Heterogeneities Leading to the Scintillation of Radio Stars, Trudy 5-go soveshchaniya po voprosam kosmogonii 1955g, Izd. AN SSSR, M. 1956), which explains the appearance of the diffused state of the ionospheric F2 layer because of its turbulence, merits special attention.

Generalizing the above, the following preliminary conclusions are made. The probability of the appearance of the diffused state the ionospheric F2-layer in the latitudes of Ashkhabad has an inverse relation to the level of solar activity.

The seasonal variation in the appearance of the diffused state of the ionospheric F2 layer in the latitudes of Ashkhabad has two maximums in the summer and winter months, and two minimums in the equinoctal months.

The regularity of the diurnal variation is controlled by local time and is similar to other ionospheric stations. The prohibited times for the appearance of a diffused state of the ionosphere are the daylight hours, i.e., the time the F-region of the ionosphere is illuminated by the Sun.

The appearance of a diffused state in the ionosphere is dependent on the geomagnetic coordinates, and, consequently, the corpuscular streams are the agents, but along with these, the state of the ionosphere itself, i.e., the "state of predisposition" to the appearence of the diffused state, plays an important role ("Diffusion Characteristic of the Ionospheric F2 Layer Over Ashkhabad and Its Relation to Solar Activity," by N. M. Yerofeyev; Institute of Physics and Geophysics, Academy of Sciences, Turkmen SSR; Ashkhabad, Izvestiya Akademii Nauk Turkmenskoy SSR, No 3, 1959, pp 10-14)

Study on Night Sky Radiation Spectrum in the 1.2-3.4 Micron Region

The spectrum of the night sky in the 1.2-3.4 micron region was recorded in a station of the Institute of the Physics of the Atmosphere at Loparskiy (near Moscow, 68 38 N, 33 20 E) in November and December 1958. A photoelectric spectrometer constructed in the State Astronomic Institute imeni P. K. Shternberg was used. The diffraction grating, 300 lines per millimeter, 150 x 150 millimeters in size, concentrating the radiation at 67 percent in the first order at a wave length of 2.05 microns (bright image angle, 18° 30') operates in a mirror autocollimating system.

The spectrum is unfolded by rotating a small stage holding the diffraction grating. Recording speed was only 0.033 or 0.0135 microns per minute. Recording of the spectrum of the night sky was produced for a spectral width of 0.02 and 0.04 microns (for different parts of the spectrum) which corresponds to a linear width of 6 and 10 millimeters for both slits. A lead sulfide photoresistor with an active surface of 2 x 2 millimeters was placed in a cooling chamber and cooled with dry ice. The relative and absolute sensitivity of the spectrometer was checked by recording a solar spectrum and the spectrum of a special low-temperature calibrated surface. The maximum sensitivity of the instrument was in the 2-3 micron region.

All observations were produced in the zenith distance z = 72 degrees, and an azimuth close to North, in clear weather, with good transparency. The wide region, 1.2-3.5 microns, was divided into separate ranges recorded several times on different nights. The spectrum obtained was divided into two parts, the "short wave" (1.2-2.5 microns), the source of which is the upper atmosphere, and the "long wave," (2.5-3.5 microns), the source of which is the troposphere.

The 1.2-1.9 micron portion in the short wave region was obtained by averaging 10 recordings, registered with a spectral width of 0.02 microns on 11-12 December. The position of the separate maximums agreed with that of oscillating OH bands.

Theoretical studies indicate the existence of intense OH radiation in this region. No other source in addition to OH radiation is now known which can produce the enormous intensities of hundreds of kilorayleighs recorded in this region. It is admitted that certain details of the spectrum could have an origin other than the hydroxyl, but it is emphasized that the principal part of the radiation observed is OH radiation. There were no strong aurora in region of the sky studied. Aurora are not usually accompanied by intense OH radiation (this is known from observations in the $\lambda < 1.2$ micron region). The results of the observations are fully related to illumination of the night sky despite the fact they were made in the zone of frequent auroras.

The distribution of intensity in the 1.2-2.5 micron region is related to the zenith. The highest integral of brightness in the 1.4-1.8 micron region were observed on 29 November (2.2×10^{-9} watts per square meter per steradian), and the lowest on 10 November (0.7×10^{-9} watts per square centimeter per steradian).

The previously uninvestigated 2.2-2.5 micron region, in which the apparatus has its highest sensitivity, was studied. No radiation, except a weak maximum in the 2.1-2.2 micron portion which was identified with the 9-7 band of OH, was found.

On the basis of the recordograms, the absolute intensitites of the 8-5, 3-1, 4-2, 5-3, and 9-7 bands of OH were estimated. These were found to be 50, 55, 60, 50, and 5 respectively. The low intensity of the 9-7 OH band was considered very important, because it diverges from the values expected on the basis of current hypotheses concerning the populations of these levels.

In the 2.5-2.9 micron region, the troposphere fully absorbs all the radiation of the upper atmosphere. Nevertheless, the 1-0 OH and the 2-1 OH bands, which must be exceptionally intensive, fall in this region. The observation of these bands at sea level is impossible because of the absorption by vapors of water (H_2O) and CO2. From 2.5 microns, the thermal radiation of the troposphere, the spectrum of which can be well observed in the 4-20 micron region where it is extremely intensive, begins to be observed. The intensity in the $\lambda > 2.5$ micron region is dependent on this radiation only. This intensity can change greatly depending on the temperature of the ground layers of the air (in this case from -40 down to -45 degrees). The neighborhood of the clearly expressed 3.16 micron band is well identified with the reverse spectrum of absorption of the troposphere in this region. The 5-5 and 6-5 OH bands (3.037 and 3.260 microns) can be observed by means of lead sulphide and lead selenide photoresistors.

The intensities of the still uninvestigated band 3-2, 4-3, 5-4 and 9-8 were estimated from the intensities obtained for the OH band. Measurement of the intensity of the OH $\Delta V = 1$ band was considered of great interest and it is suggested that an attempt at such measurements be made with a high-altitude airplane. ("Spectrum of Night Sky Radiation in the 1.2-3.4 Micron Region," by V. I. Moroz, State Astronomic Institute imeni P. K. Shternberg; Moscow, Doklady Akademii Nauk SSSR, Vol 126, No 5, 1959, pp 983-985)

East Germany Activates Europe's Second Largest Radiotelescope

A radiotelescope rated as being the second largest in Europe has become operational at the Heinrich Hertz Institute, Academy of Sciences GDR. The equipment mounts a parabolic mirror 36 meters in diameter, which serves as a reflector in investigations of radio emissions in the cosmos. A photograph of the radiotelescope is presented but no additional information is given. ("Around the World -- 'Window' Into the Universe"; Moscow, Tekhnika Molodezhi, No 6, Jun 1959, p 30)

Vertical Circle at Ukrainian Observatory To Be Checked

The vertical circle of the Main Astronomical Observatory of the Academy of Sciences Ukrainian SSR will be used in the coming years for an absolute determination of the declinations of fundamental stars of catalogues FK3 and FKS3 (detailed report on the instrument in article by G. Struve, Publications of the Berlin-Babelsberg University Observatory, Vol 3, No 1, Berlin, 1919). This will necessitate a detailed investigation of the graduation errors of the graduated circle, since such an investigation has never been made.

This article discusses the choice of the most rational method for this investigation, which will involve a considerable work. A comparison of the corrections of the diameters expressed in degrees, obtained according to the complete and the abridged Bruns methods, convincingly shows that the abridged program will be sufficiently accurate and yet will reduced the number of measurements and the amount of final data processing considerably. ("Investigation of the Graduation Errors of the Vertical Circle of the Main Astronomical Observatory of the Academy of Sciences Ukrainian SSR," by I. D. Dzyuba; Kiev, Izvestiya Glavnoy Astronomicheskoy Observatorii, Vol 2, No 2, 1958, pp 87-114)

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Hungarian Astronomers Study Changes in Martian Atmosphere

Hungarian astronomers, workers at the TIT [Society for the Propagation of Scientific Knowledge] Urania Observatory, are planning to make a continuing study of Martian "weather." The object of the observations will be an examination of the transparency of the Martian atmosphere. Inasmuch as cloudiness at any one spot in fall and winter permits only rare observations, the Urania Observatory sent invitations to several similar observatories for organizing joint work. The Urania Observatory in Vienna and the Zagreb Observatory joined in the program. The Budapest observatory collected the data. From September 1958 to the beginning of 1959, 82 observations were carried out. An interesting discovery was that the changes in the "weather" of Mars follow Earth disturbances by 1-2 days. This can be explained by the fact that Mars is further from the Sun than is Earth and thus the [solar] radiation must travel further. It was established that Mars also has a magnetic field the magnetic strength of which is half that of Earth's. The Hungarian and foreign astronomers are continuing their joint observations. ("Hungarian Astronomers Will Study Weather on Mars"; Budapest, Magyar Nemzet, 4 Aug 59, p 6)

III. METEOROLOGY

Soviet Geophysical Expedition to Karakum Desert

An integrated scientific expedition of the Main Geophysical Observatory imeni A. I. Voyeykova has been flown into Tashkent and from there into the Karakum Desert. It is made up of about 70 associates from the observatory, the Leningrad Hydrometeorological Institute, and the Central Asia Scientific Research Hydrometeorological Institute. The expedition is headed by Prof D. L. Laykhtman.

The principal aim of the expedition is the conduct of detailed observations and measurements of vertical flows of air in relation to the study of the interaction between meteorological conditions near the Earth's surface and the layers of the atmosphere above 1,000 meters. This work undertaken by the geophysicists is of great value for studying the elements which form the weather and the microclimate. The Karakum Desert is the most suitable region for the investigators.

A specially equipped airplane is at the disposal of the expedition. It is equipped with radar and other instruments. For the first time Soviet scientists will make use of radio-controlled model airplanes designed for sounding the lower layers of the atmosphere. These models have a wingspread of three meters, a speed of about 40 kilometers per hour, and a range of about 3 kilometers. They have a ceiling of 300-400 meters. The airplanes carry a small meteorograph weighing about 400 grams, which records the temperature, pressure, and humidity of the air. The construction of the flying models was developed by associates of the Main Geophysical Observatory under the supervision of P. A. Vorontsov, Candidate of Geographical Sciences. Radio equipment was built by V. I. Mikhkyurya, Candidate of Physicomathematical Sciences.

The use of a radio-controlled glider equipped with a meteorograph is also planned. Theodolites on the ground will be used to observe its flights. The expedition also has a helicopter for studying the lower layers of the atmosphere.

The work of the expedition is expected to take 35-40 days. ("Air Expedition of Geophysicists"; Moscow, Sovetskaya Aviatsiya, 2 Sep 59, p 4)

Solution of Equation for Variation of Geopotential

In the majority of cases, present-day mathematical methods of short-range prediction of the pressure field boil down to some method of solving the equation for $\partial z/\partial t$, which is the local derivative of the height of the corresponding isobaric level. Ordinarily, such an equation is obtained from an equation for the vertical component of the vortex on the basis of the hypothesis of the quasigeostrophicity of atmospheric motions. Generally, the equation for $\partial z/\partial t$ is found in the form

$$L \left\{ \frac{\partial z}{\partial t} \right\} = F\left(x, y, \zeta ; z (x, y, \zeta, t)\right),$$

where L is the linear differential operator effecting only the coordinates. The concrete form of the operator L depends on the method used in the treatment of the original equations of hydrothermodynamics. As a rule, F comprises the nonlinear terms, which allow for the advection of the vortex, and, in the case of the nonbarotropic model, the temperature, as well as the linear term which takes into account the change of the Coriolis force with latitude. Here, x and y are the horizontal coordinates, and $\zeta = p/p_0$ is the dimensionless vertical coordinate; p is the pressure at the z level, and p_0 is the standard pressure at the earth's surface, approximately equal to 1,000 mb.

In this article, the ordinary operator L is expanded because of the linear term which takes into account the variation of the Coriolis parameter with latitude. With a simple barotropic model as an example, the basic qualitative characteristics of the obtained solution are determined, and a variant solution is given for the baroclinic model with spherical coordinates. ("Solution of an Equation for Measuring the Geopotential," by Ye. M. Dobryshman; Moscow, Trudy Tsentral'nogo Instituta Prognosov, No 78, 1958, pp 92-104)

IV. OCEANOGRAPHY

Mikhail Lomonosov Stops in New York on New Voyage

The Mikhail Lomonosov, expeditionary ship of the Marine Hydrophysics Institute of the Academy of Sciences USSR, sailed from Riga on 8 August for New York, where it plans to arrive in time for the opening of the First International Oceanographic Congress.

Prof A. G. Kolesnikov, Doctor of Physicomathematical Sciences, chief of the expedition, said in an interview before departure that the voyage will proceed according to the IGC program. Soviet scientists will conduct detailed studies of the water masses of the Atlantic Ocean and the atmospheric layers above it.

New Soviet electronic apparatus will be used for the first time on this voyage, which will permit making systematic observations directly in the depths of the ocean. The instruments are housed in special containers. Readings of the instruments will be transmitted via a multiple-core cable and recorded automatically in the ship's laboratories. The "floating institution", as Kolesnikov calls the ship, has a large scientific staff.

The voyage will last 4 months, during which time, in addition to New York, the ship will visit the Azores and ports in Africa and England. ("Course--Towards the Shores of America;" Moscow, Pravda, 9 Aug 59)

The Mikhail Lomonosov arrived in New York on 30 August where its complement of 70 scientists will take part in the First International Oceanographic Congress, which opens 31 August. ("Short Reports"; Moscow, Izvestiya, 30 Aug 59, p 5)

V. SEISMOLOGY

New Seismic Stations in Siberia and in the Far East

The enormous territories of Siberia and the Far East, in particular the Baykal zone, have been studied very little by seismic methods up to now. Today, with the organization of the Siberian Division of the Academy of Sciences USSR, the scale of investigations in the field of seismology has been considerably expanded. According to the plan approved by the Council on Seismology, the Siberian Division is starting extensive construction of seismic stations. New general and regional type stations will be opened during 1959 and 1960 in the Altay-Tuvinskiy, Baykal, Yakutsk, and Far East zones. During the period 1961-1965, new stations in Abakan, Narym, Noril'sk, Chita, Blagoveshchensk, Komsomol'sk-na-Amure, Okhotsk, on the Chukotskiy Poluostrov, and in other localities will be set up. The stations, which will be equipped with the most modern instruments, will conduct systematic observations, record movements arising in the Earth, and generalize data related to the seismicity of the separate regions and zones. ("New Seismic Stations in Siberia and the Far East"; Moscow, Priroda, No 8, Aug 59, p 112)

VI. GEOMAGNETISM

Measurements of Magnetic Perturbations Analyzed on Basis of Stormer Theory

As a result of a study of magnetic perturbations which was conducted at the Arctic Institute during the years 1938-1948, we have observed new facts and laws concerning these phenomena and have made a number of attempts to explain their nature. However, as a result of a broader knowledge of magnetic perturbations in high latitudes, it is now necessary to reconsider some of our conclusions and explanations from new points of view.

We had earlier hypothesized that morning and night magnetic perturbations, which are characteristic of high latitudes, were caused by solar particles of different sign, primarily by electrons and protons. This hypothesis was based on a consideration of many facts. One of the most important of which is the following.

If a curve of the distribution of magnetic activity over the course of a day is drawn on the basis of Bukhta Tikhaya data (according to the hourly characteristics) separately, for strong magnetic storms and for the remaining days, a shift in the morning maximum to later hours and in the night maximum to earlier hours is clearly observed in the days with storms. Assuming that the average velocity of the corpuscles in solar corpuscular flows responsible for large magnetic storms is greater than in flows causing weak storms, it was natural to explain the shift in the maxima of the activity as due to this fact. The different effect in the change in time for the appearance of the maximum in morning and night perturbations could be interpreted as an indication of the change in sign of the corpuscles responsible for morning and night perturbations.

Our more recent investigations, based on a greater amount of data from a larger number of stations, made it possible to draw new conclusions concerning the nature of magnetic perturbations in high latitudes. It was shown that the isochroms of the morning maximum of magnetic perturbations form spirals passing from the field of uniform magnetization and turning clockwise. We interpreted these spirals as spirals of the precipitation of the solar particles of Stormer. The cause of the morning perturbations in this case must be protons. The fact of the influx of protons into the upper layers of the Earth's atmosphere is not hypothetical at present. We had earlier assumed that morning perturbations were caused by electrons, which was evidently not true. Bennett's ideas on the self-focusing flows of solar corpuscles indicates the possibility of bunches protons approaching the Earth. The possibility of bunches of protons, which can travel in Stormer trajectorus close to the Earth, penetrating to the Earth is indicated by S. B. Pikel'ner. Thus, the possibility of protons penetrating to upper layers of the Earth's atmosphere is theoretically well-founded than the possibility of the penetration of electrons.

Serious attempts are now being made to develop a theory of aurora and magnetic perturbations of the Birkeland-Stormer type. These attempts are explained particularly by the fact that since the observation of ionized gas of sufficient density in interplanetary space, the criticism of the Birkeland-Stormer theory made by Shuster, Lindemar, and Ferraro becomes invalid since it was assumed in this criticism that interplanetary space is empty. The most interesting and promising investigations in this regard were made by Bennett.

It may be hypothesized as a consequence of Stormer's theory that regions exist in the Arctic in which a thickening of the proton trajectories occurs on the precipitation spirals of charged particles, including those for protons. These regions are centered at 15, 20, 02, and 08 hours local geomagnetic time; we have called them, respectively, regions A,B,C, and D.

From indirect observations of the morning maximum of the magnetic perturbations, we were able to draw the spirals in a longitudinal direction to only a limited extent, on the order of 180 degrees. It may be hypothesized as a consequence of Stormer's theory for terrestrial conditions that the actual spiral of proton precipitation in the Arctic completes 360 degrees, i.e. every 24 hours. On the basis of more material and additional considerations, we have determined in the first approximation the zones A, B, C, and D on the Earth's surface which represent the geometric location of the displacement of the regions A, B, C, and D within one revolution of the Earth around its axis. It may be hypothesized in this case that the night maximum of the magnetic perturbations will represent no other than the total effect of the Stormer zones B and C occurring at 20 and 02 hours respectively. If this is so, then both the morning and night magnetic perturbations are the result the influx of only protons into the upper layers of the Earth's atmosphere.

This conclusion is in complete contradiction to that hypothesized by us earlier, namely, that the morning and night perturbations are caused by particles of different size, by electrons and protons. Until this series of contradictions is resolved, it is impossible to carry out any further physical interpretation of the observed facts.

Analysis of the consequence of Storm's theory makes it possible to resolve this contradiction. Actually the displacement of the time of the morning maximum of the magnetic purturbations in Bukhta Tikhaya on days with strong magnetic storms to later hours directly follows from stormser's formula

$$\sin \Theta = \sqrt{2 a \sqrt{m/v/Me}},$$

where β is the declination of the spiral from the pole for a given value of γ_1: m is the mass of the proton, v is velocity, e is charge, M is the magnetic moment of the Earth, a is the radius of the Earth, $\gamma_1 = -\gamma$ (γ is the integration constant in the solution of Stormer's equation.)

It follows from this formula of Stormer, that the angular separation of the departure of the spiral from the Pole depends particularly on the velocity of the corpuscles. In the case of an increase in the average velocity of the protons in the flow, the entire spiral moves to the South and the Southeast. This means that there passes through Tikhaya not a 4-hour spiral (according to GMT) which is characteristic for average conditions, but a 6-7 hour spiral which occurs under average conditions northwest of Tikhaya. Under a statistical analysis of the observations for a large number of storms this displacement of the spiral of precipitation appears as a displacement in the time of the morning maximum of the perturbations to later hours.

Can this displacement of the night maximum to earlier hours on days with extensive storms be explained, if it is assumed that the night maximum is caused by protons and lies on the spiral of their precipitation. It may be pointed out that this displacement will occur as a result of a change in the value of γ (integration constant in the solution of Stormer's equations) toward larger negative values, up to values of γ equal to approximately minus 1, and that these changes in γ itself are a consequence of a rise in the velocities of the corpuscles.

Actually the physical meaning of the value of γ, as Montgomery and Mitra have shown, reduces to the following. At great distances from the origin (from the center of the Earth) γ represents the instantaneous value of the velocity moment of a particle relative to the dipole axis (i.e. $-2\gamma = R\dot{\omega}$, where R is the distance from the Earth to the point and $\dot{\omega}$ is the angular velocity. It may be shown that $-2\gamma = D \cos \beta$, where $D = R \sin \delta$ and β is the angle between the direction of the velocity of the particle and the equatorial plane (δ is the angle between the projections of R and v on the equatorial plane.) The distance D is expressed here in Stormer's units of length. But D Storm un = Dcm/C, where $C = \sqrt{Me/mv}$; consequently $-2\gamma = D \text{ cm} \cos \beta \sqrt{mv/Me}$

It follows from this that with an increase in the velocity of the particle, the magnitude of the negative value of γ increases. The figure shows that an increase in the negative value of γ will have as a result a displacement of the point of incidence of a particle to the West. This means that the perturbation will appear earlier.

It should be kept in mind that the night maximum at Tikhaya, if it is also connected with the influx of protons, must be considered as the total effect of the influence of the Stormer zones B and C situated respectively on the 17- and 23-hour (according to GMT) spirals of precipitation passing south of Tikhaya.

Thus changes in the velocity of the protons in the flow approaching the Earth will have a double effect on the time of their influx into the Earth's atmosphere. First, with a rise in the velocity of the protons, the spiral of precipitation moves to the southeast, appearing as a displacement in the morning maximum to earlier hours; second, a rise in the velocity of the corpuscles, changing the value of γ towards higher negative values, will produce a declination of the protons to the West, i.e., the earlier appearance of magnetic perturbations.

Theoretically, both of these effects of the change in the velocities of the protons will appear simultaneously, which effect will be expressed more strongly depends on the position of the station. In those areas through which the spiral passes, sharply, at small angles to the meridians (for example Bukhta Tikhaya and more northern points,) a great effect for the morning perturbations will cause a displacement of the whole spiral of precipitation to the southeast. Conversely, at stations situated more to the south, where the spirals pass almost perpendicular to meridians, changes in the value of γ will play a greater role with the night perturbations.

Hope explains the different displacement of the morning and night maximums by the different effect of the change in the inclination of the Polar region to the Sun over the course of 24 hours during the time of the incidence of corpuscles to the Earth which pass in the Stormer trajectories at great angles to the Poles in the case of morning perturbations and at small angles for night perturbations.

The many observations of aurora show that in days with strong magnetic storms and intense aurora, the southern boundary of the latter moves to the south and the time of their appearance is displaced to earlier hours. These facts can be explained in the same way as in the case of the displacement of the morning and night maximums during the daily change in magnetic activity.

The change in the velocity spectrum of protons in days with intense showers toward higher velocities plus the change in the spectrum of values of gamma towards greater negative values (up to $\gamma \simeq -1$) can explain one more well-known fact: with an increase in the total intensity of a magnetic perturbation, (particularly in Bukhta Tikhaya), the greater is the increase in the intensity of the night maximum. The changes in the velocity spectrum and in the spectrum of the values of gamma towards greater values may be such that they will more effectively act on the section of those values of gamma at which the most intense precipitations of protons occur in the zones B and C responsible for night perturbations.

It is obvious that there is on the average a certain velocity spectrum which in some degree itself determines the spectrum of the values of gamma. The appearance on certain days of active periods of magnetic perturbation will be determined among other factors, by the presence of suitable velocities in the flow and corresponding values of gamma. The influx of protons in every precipitation spiral (with respect to 360 degrees of latitude) is possible only for a wide spectrum of the values of gamma (from - 0.1 to -1.0.) The length of the active periods will depend particularly on the distribution of the values of gamma with respect to the spiral.

Kaiser and Bullough have observed that two maxima, at 18-19 and 01-02 hours local time were observed in the frequency of aurora on the basis of radar observations at Jodrell Bank and that an actual motion of aurora of the reflecting regions occurs along the geomagnetic parallel and its velocity changes from 600 meters per second (on the average) to the west at 16 hours local time to 600 meters per second to the east at 5 hours.

We have hypothesized that the time of the maxima in the frequency of the appearance of aurora may be explained from the existence of Stormer zones B and C. The displacement of the aurora to the west in the evening and to the east in the morning may evidently be explained in the following manner. It is evident from an analysis of the shape of the spirals of proton precipitation in the Arctic that a fixed region (for example the region of constant gamma) located on the spiral will at the same hours of the day pass the Earth in its daily rotation, which will be taken as a displacement of the ionized regions (aurora) to the East, and at other hours will depart from the rotation of the Earth, which will be taken as a displacement of the aurora to the West.

The results indicate that in the development of a model of the origin of magnetic perturbation at high latitudes, the Stormer theory will occupy a very important position. ("Solar Protons as the Cause of Morning and Night Perturbations at High Latitudes, by A. P. Nikol'skiy, Arctic and Antarctic Scientific Research Institute; Moscow, Doklady Akademii Nauk SSSR, Vol 127, No 1, 1 Jul 59, pp 82-85)

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